

**Heathkit of the Month #92:
by Bob Eckweiler, AF6C**



AMATEUR RADIO - SWL

**Heathkit SW-717
General Coverage Communications Receiver.**

Introduction:

Over its lifetime Heathkit Company manufactured 17 general coverage (GC) communications receivers. To be considered in this arbitrary category the receiver must cover the AM broadcast (BC) band and a significant portion of the frequencies above it in the HF range that ends at 30 MHz. The coverage should be mostly continuous, though gaps for technical reasons are acceptable¹. Additional coverage, such as the LW band below the BC band or frequencies above 30 MHz, is allowed. Some of the included Heathkit GC receivers only cover to 10 MHz and others only to 20 MHz. Superheterodyne receivers make up 14 of the 17, the other three being super-regenerative receivers. Ham-band only and even band-oriented SWL receivers are not considered general coverage, so you won't see the SB receivers on the list.

Evidently, general coverage kit receivers were a profitable product; they seemed to be a popular beginner's kit as well as a moderate kit for the more experienced kit builder. Heath focused on having one or two receivers on the market for the beginner, usually at very reasonable prices for modest performance. They also manufactured some higher



Figure 1: SW-717 General Coverage Receiver
Note substitute knob to left.

performance receivers as well as portable receivers that could run off batteries. Features varied with cost; crystal filters, dual conversion, S-meter, an RF amplifier stage and a tracking bandspread control are often missing on the low-end radios.

The first receivers were the super-regenerative K-1 and K-2 (HotM #s 80 & 81). They were followed by the superheterodyne AR-1 through AR-3. In 1960 Heath released their first transistorized GC receiver, the Mohican GC-1, later updated to the GC-1A (HotM #34).

As part of Heathkit's early educational series they produced the EK-2A and EK-2B "Basic Radio Educational Series" in two parts. In part one the student builds various circuits including a crystal receiver and later a regenerative receiver. However, in part two the receiver is modified and expanded into a six-tube general coverage superheterodyne receiver that covers the broadcast band and 3 to 10 MHz; passing the GC requirements.

Around 1961 Heath started the GR receiver line which includes general coverage short-wave radios along with many other general radios including clock radios and AM/FM portables. Qualifying GC receivers from this group are (in chronological order) the GR-81, GR-91, GR-64, GR-54, GR-43[A] and GR-78 (HotM #62). The solid-state GR-43 and its 'A' update are clones of the Zenith Transoceanic

Here is a link to the index of Heathkit of the Month (HotM) articles:
http://www.w6ze.org/Heathkit/Heathkit_Index.html

portable shortwave receiver. **Table I** is a timeline of the 17 Heathkit GC receivers.

By the late sixties the Japanese radio invasion was making competition difficult for Heathkit. After 1969 Heathkit released only two new GC receivers, the SW-717 in 1971 and the SW-7800 in 1984, both solid-state.

The Heathkit SW-717 General Coverage Communications Receiver:

Figure 1 is a photo of the SW-717 receiver. It first appeared in the second half of-1971, too late to make the main 1971 catalog. In the 1972 catalog² that came out late in 1971 the SW-717 sold for \$59.95. An accessory long-wire antenna kit (GRA-72)³ sold for \$2.95. By 1976 the price had started to rise: 1976 - \$69.95, 1977 - \$74.95, 1978 - \$77.95, 1980 - \$99.95. The last price found is \$119.95 in the Christmas 1981 catalog. Meanwhile the accessory long-wire antenna went up to \$4.50, and in 1981 to \$7.95. When the SW-717 stopped production Heathkit would not put out another GC receiver until 1983 when it introduced the multi-hundred dollar synthesized SW-7800 shortwave receiver.

The SW-717 is a tabletop sized radio measuring 14-1/2" W x 5-3/4"H 10" D. It is a basic radio with few frills. It covers the broadcast band and up to 30 MHz in four bands clearly marked on a slide-rule dial. The I-F uses three 455 kHz ceramic filters instead of I-F transformers, which alleviates the need to align the I-F stages. It has an S-meter that gives relative signal strength. The SW-717 specifications are shown in **Table II**.

The SW-717 Front and Rear Panels:

The front panel has six controls, two slide-rule dials, a 1/4" phone jack for earphones and a small S-meter marked **SIGNAL** with a graduated scale marked 0-5. A large black plastic slide-rule dial plate with green and white markings covers about 70% of the

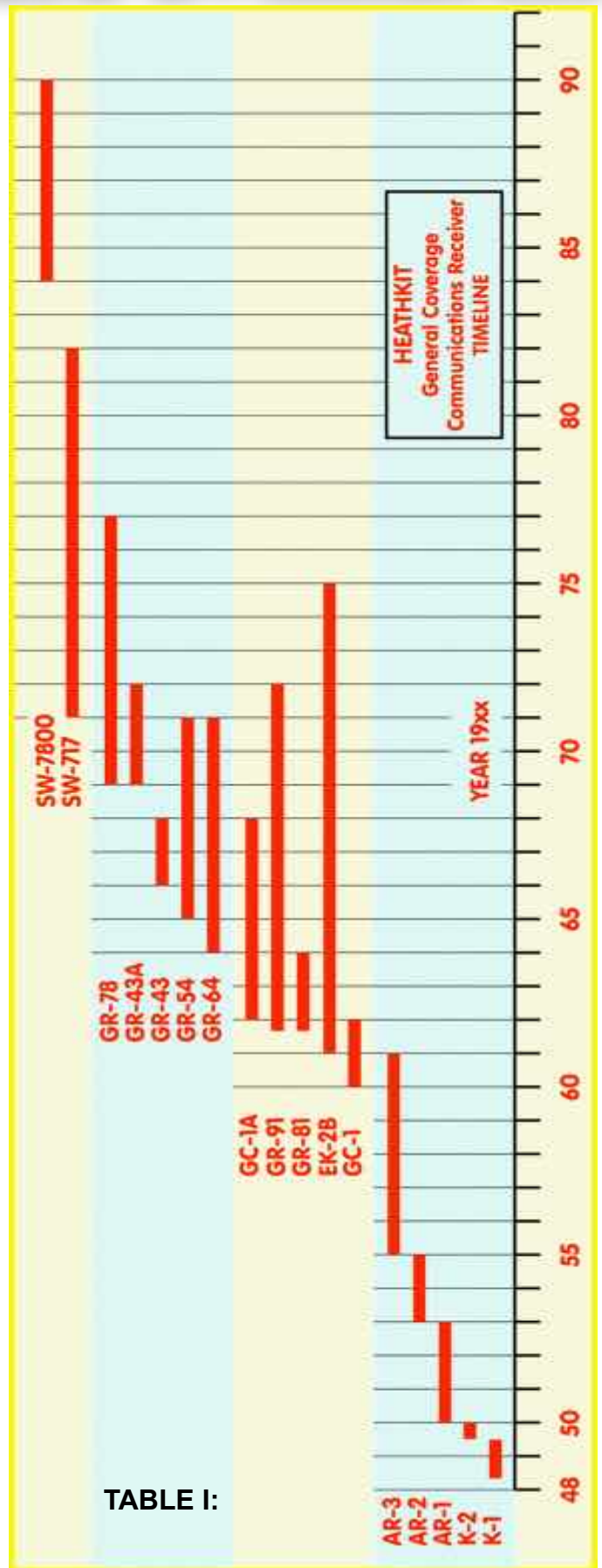




Figure 2: SW-717 General Coverage Receiver Rear view showing ferrite AM band antenna.

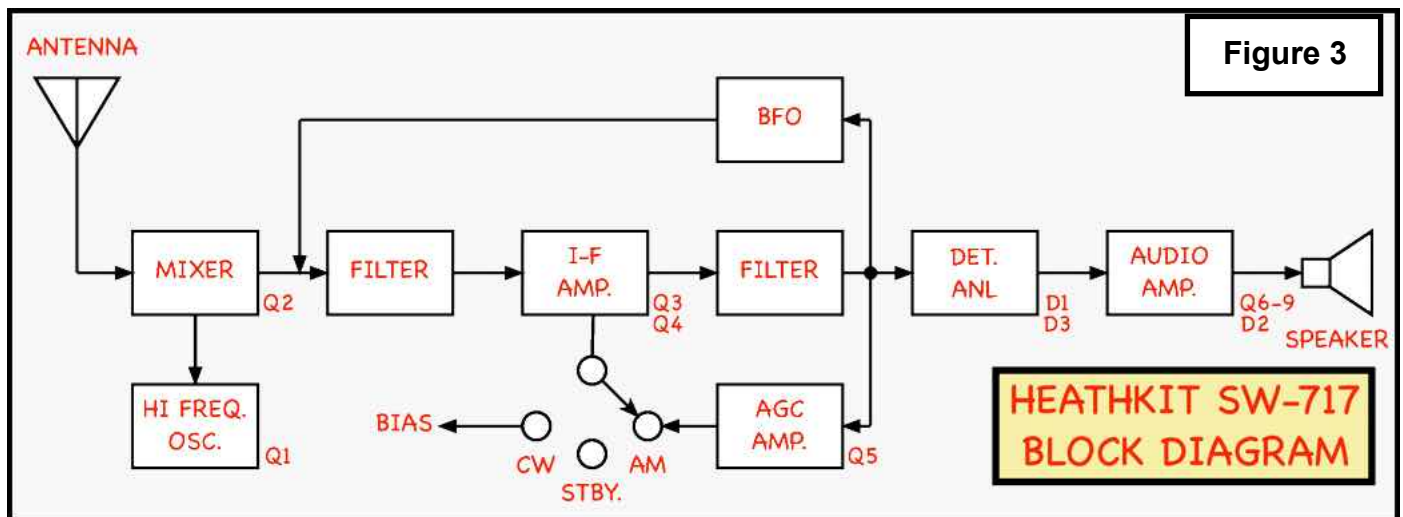
The rear panel (**Figure 2**) is rather barren. Everything is located along the bottom edge. From left to right (as viewed from behind) is the ferrite rod antenna for the broadcast band, the 3-wire AC power cord, a two screw-type terminal strip marked **ANT** and **GND** and a two-position slide switch marked **OFF ANL ON** (automatic noise limiter).

The SW-717 has a built-in speaker located on its right side-panel; an external speaker may be plugged into the PHONES jack since it is low impedance, taken directly off the internal speaker.

The SW-717 operates on 120/240 VAC 60/50 Hz. depending on how the transformer primary is wired. The instruction manual includes the necessary information should it need to be changed. The receiver draws 8-watts.

The SW-717 Circuit:

Superheterodyne receivers have been discussed in prior reviews so only the highlights will be covered. **Figure 3** is a simple block diagram of the SW-717, showing its simplicity. Only the more unusual aspects of the circuits will be covered in some detail. A schematic of the SW-717 is available online⁴ and a smaller copy (**Figure 9**) is reproduced at the end of this article.



The Front End:

The front end normally designates everything up to the first IF stage, usually the RF amplifier, oscillator and mixer. The SW-717 has no RF amplifier. The input from the antenna is coupled by separate LC circuits for bands 'B' through 'D' directly to the mixer Q2. Band 'A', the broadcast band, uses the tuned ferrite rod antenna as its coil and is not connected to the external antenna connector. The mixer incorporates an RCA 40673 dual-gate MOSFET.

The HF oscillator Q1 uses a Motorola MPF-105 JFET. Power to the oscillator is regulated by a zener diode for added stability. The IF operates at the standard 455 KHz and the oscillator operates above the received frequency on bands A, B and C and below it on band D. The bandspread only adjusts the oscillator frequency. This is also true on the GR-78 and means as the bandspread is tuned the input coils are not also tuned resulting in some minor loss of sensitivity. The oscillator signal is coupled to the second gate of the mixer MOSFET.

The I-F:

The signal from the mixer is fed through two 455 KHz ceramic filters in series before being coupled to a 2N5308 high gain Darlington transistor (Q3). A small un-bypassed emitter resistor provides some degenerative feedback for stability. The output of Q3 is coupled to Q4, a conventional 2N5232A transistor which provides additional I-F gain and impedance matching to a third ceramic filter. Output from the I-F after the filter is fed to the detector stage and also to the AGC amplifier.

The BFO:

The SW-717 uses an unconventional BFO circuit. This was probably done as a cost savings measure. Output from the third IF filter is fed back through a potentiometer desig-

| | |
|--|---|
| Frequency Coverage: | |
| Band A | 550 kHz to 1500 kHz |
| Band B | 1.5 MHz to 4 MHz |
| Band C | 4 MHz to 10 MHz |
| Band D | 10 MHz to 30 MHz |
| S-Meter: | Indicates relative signal strength. |
| Headphone Jack: | Low impedance headphones or external speaker. |
| Loudspeaker: | Built in. |
| Controls: | |
| VOLUME | with on-off switch. |
| MODE | AM, Standby and CW. |
| MAIN TUNING | |
| BANDSPREAD TUNING | |
| ANL | ON - OFF (On rear panel) |
| Transistor Complement: | |
| 40673 (RCA) | Mixer |
| MPF105 (Motorola) | HF Oscillator |
| 2N5308 | I-F Amplifier |
| 2N5232A (Qty: 2) | I-F and AGC Amplifiers |
| 2N3393 | Audio Preamplifier |
| X29A829 (GE) | Audio Driver |
| MPSU05 (Motorola) | Audio Output (NPN) |
| MPSU55 (Motorola) | Audio Output (PNP) |
| Power Supply: | Transformer operated. Full-wave bridge rectifier. |
| Power Requirements: | 120 or 240 VAC 50/60 Hz 8 watts (3/4 amp fused). |
| Dimensions: | 14-1/2"W x 5-3/4"H x 10"D |
| Net Weight: | 7 lbs. |
| TABLE II :SW-717 SPECIFICATIONS | |

nated **BFO** to the input of the input of the first ceramic filter. In AM the BFO control is set to zero; in CW the BFO control is advanced and the I-F starts to oscillate at the 455 KHz frequency of the filters. the level of oscillation can be adjusted by the BFO control; however, to change the tone you have to

adjust the main or band spread tuning. This takes some practice to be able to tune in an SSB signal. The BFO control can also be used to increase the sensitivity of the receiver when receiving AM signals by introducing regeneration. When receiving a weak AM signal, the BFO control may be advanced slowly for the best signal reception. Advancing the control too far will result in oscillation.

The AGC, S-Meter and Mode Switch:

The I-F signal is coupled to the automatic gain control (AGC) circuit, through a small capacitance. It is rectified and amplified by Q5, a 2N5232A transistor. Its output is a positive voltage that is dependent on received signal strength. Stronger signals result in a lower positive voltage. This voltage is fed to a milliamp meter that indicates relative signal strength. The other side of the meter is returned to a positive voltage through the meter zero setting potentiometer.

The output of the AGC amplifier is filtered by a pi R-C network composed of C15, C16 and R23 producing a slow decay AGC voltage that is fed back to the bases of the I-F transistors Q3 and Q4, reducing their gain on strong signals.

The MODE switch has three positions. In the AM mode, the AGC is fed back to the I-F as described in the previous paragraph. In STBY the positive bias is removed from both I-F stages causing them to be biased to cut-off. In the CW position a fixed positive bias is applied to the I-F stages instead of the AGC voltage, causing the stages to run at a high gain regardless of signal strength. This bias is set by R24.

The Detector and ANL:

Output from the third I-F ceramic filter is also fed to a simple diode detector circuit that utilizes a 1N191 crystal diode (D1). The

recovered audio is fed to the VOLUME control and to the audio amplifier circuit. In noisy conditions the ANL diode (D3) may be switched in to clip any positive noise peaks.

The Audio Amplifier:

The audio amplifier consists of four transistors, Q6 through Q9. Q6 is a small signal NPN audio amplifier that directly drives Q7. C23 limits high frequency noise. Q7 drives Q8 and Q9, complementary power transistors. Q8 is an NPN MPSU05 and Q9 is a PNP MP-SU55. Diode D2 is a "Stabistor diode, which has a stable forward voltage drop over various currents and temperatures. It helps prevent thermal runaway by the power output transistors. This diode is normally mounted in close proximity to the output transistors so it experiences their temperature environment. The amplifier's low impedance output is coupled through C26 and the headphone jack to drive the internal speaker.

The Power Supply:

Being one of Heathkit's later kits, the power cord is three wire and the transformer can be wired for either 120 or 240 VAC power. A transformer rated about 18 VAC CT provides 22 volts to the audio amplifier and 10 volts at about 30 ma to the rest of the receiver. The low-voltage full-wave power supply, fused at 0.75 amps, is conventional with one exception; there are two transistors that act as zener diodes between the output of the bridge rectifier and ground. These transistors (D9 and D10) each have their collector lead clipped off and the two emitter base junctions of the transistors are connected in series. Normally they are back biased, but when the voltage reaches a point where the junctions go into avalanche conduction they act as zener diodes. This appears to be a protective circuit to limit any power line spikes from reaching the sensitive transistors.

Building the SW-717:

Heathkit advertised this radio as being a “Three Evening Kit”, the time in which the average builder could successfully assemble it. Much of the circuitry is located on a single circuit board. As always, prior to assembly the manual recommends you familiarize yourself with the parts. Taking inventory is the easy way to do this. This kit comes with the parts separated into two “packages”. Pack #1, which is the majority of the small components that mount on the circuit board and pack two, which is called the final pack and includes the larger items such as the metal chassis parts as well as the circuit board, hookup wire, nut starter tool, solder and documentation.

Since sometime in very late 1961 Heathkit started including solder with their kits, often in liberal quantities. The reason likely was because they were getting a lot of returned kits that used non-electronic types of solder. Heath supplied solder in 3’ rolls, each sealed in a plastic bag (See **Figure 4**) Usually at least one package of solder remained unopened, often several, when the kit was completed. First Alpha and later Kester provided the solder. In larger kits you would find a handful of these bags.

With parts pack #1 and the manual, solder and the circuit board from the final pack, the circuit board is stuffed. Seven pages of the Heathkit manual detail stuffing the board which includes the input and oscillator coils and the oscillator trimmer capacitors.

Once the board is complete, Heathkit suggests you inventory the remaining parts. Again, this is more for your familiarization of parts than that they expect you to find parts missing.

Assembly then begins on the chassis which involves mounting the major parts such as

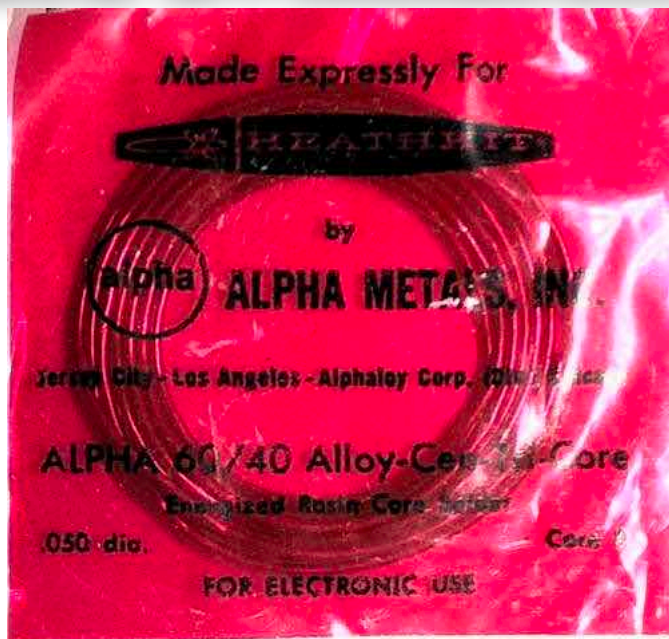


Figure 4: Heathkit supplied packets of solder with their kits. This is manufactured by Alpha. Later Kester was a supplier but used clear bags.

solder terminal strips, the power transformer and power supply components, main and bandspread tuning capacitors, switches and pots, pilot light sockets, etc. At this time the pulleys, shafts and mechanical parts associated with the tuning capacitors are also in-



Figure 5: Top interior view of the SW-717. Note the circuit board to the right and the main tuning capacitor and can capacitor along the center. The twisted blk/whi wires go to the speaker attached on the cover partially visible to the left

Put together an exciting Heathkit short wave-listening hobby



**3
EVENING
KIT**

Tune in the world on a budget

| | | |
|---|--------------|--|
| A | 550-1500 kHz | Local AM entertainment band |
| B | 1.5-4 MHz | Marine, weather and local amateur band |
| C | 4-10 MHz | Europe, Latin America, Asia & U.S. (amateur) |
| D | 10-30 MHz | U.S. & Foreign (amateur), overseas, local (CB) |



Most components mount on single circuit board for easy assembly.



Heathkit 4-band solid-state "Beginners" SWL Receiver tunes from "Rock" to Russia for only... \$59.95 NO MONEY DOWN

Ideal beginner's kit... most components mount on single circuit board for easy check-by-step assembly in about three evenings. Tunes foreign broadcasts from around the globe — weather reports — ships at sea — amateur and CB bands — plus local AM entertainment. Features slide-rule tuning; log-scale; bandspread tuning for separating adjacent stations; variable BFO for clear code reception; built-in speaker; front panel jack for headphone or external speaker; switched automatic noise limiting; signal strength meter; built-in AM rod antenna plus connection for SWL antenna.

Kit SW-717, 10 lbs., mailable \$59.95

SW-717 SPECIFICATIONS — Frequency Coverage: Band A — 550 kHz—1500 kHz. Band B — 1.5—4 MHz. Band C — 4—10 MHz. Band D — 10—30 MHz. Meter: Indicates relative signal strength. Headphone Jack: Accepts low impedance headphones or external speaker. Loudspeaker: Built-in. Controls: Volume with on/off switch; Mode (AM, Standby & CW); BFO; Main Tuning; Bandsread Tuning; ANL on/off. Transistor Complement: 40673, Mixer & RF amplifier; 2N3393, Audio preamplifier; 2N5232A, IF amplifier, AGC amplifier; 2N5308, IF amplifier; MPF105, oscillator; S2090, final audio amplifier; S2091, final audio amplifier; X29A829, Audio driver. Power Supply: Transformer operated; full-wave bridge rectifier. Voltage Requirements: 120/240 VAC, 50-60 Hz, 8 W. Dimensions: 5½" H x 14½" W x 8" D.

Figure 6: An ad for the Heathkit SW-717 from the 1972 factory catalog #800/40 (page 30).

stalled. The fiber board rear cover is added along with its ferrite rod antenna, wiring of these devices is begun and the the circuit board is installed and wired to the chassis mounted components. The band switch is added next with lots of connections to the circuit board. Much of the final wiring is then finished including a few shielded cables and the power cord. instructions are given for wiring the power cord for either 120 or 240 volts.

At final assembly the pulleys are added and the main and bandsread tuning dials are strung with their dial pointers. Each dial cord comes pre-cut to length, a nice touch. The front panel is attached along with the knobs,-pilot lamps and S-meter. The bottom panel is assembled with rubber feet but not yet attached.

Final testing comes next with resistance and voltage checks. If all checks out the bottom plate is mounted and you may align the receiver with or without test instruments. Of course test instruments (this kit requires a simple signal generator and a VTVM, both available from Heathkit or other places) will give better results, though the non-test equipment will produce good results - a feat Heathkit has been famous for during its reign.

Throughout the building of the kit are clues that Heathkit was cutting corners to keep the price of the kit down. Most notable is that the S-meter and the speaker are mounted by double back foam tape. For the speaker it does provide acoustic isolation, however the meter is taped to both the front panel and the front sub-panel, making any later

disassembly problematic. Also, the front panel is plastic and the paint is rather thin so that after a little wear light from the two pilot lamps can be seen through any scratch or even the silver paint. Heathkit tried to reduce this by putting some opaque tape between the right hand pilot lamp and the front panel. This pilot light indirectly illuminates the band spread slide rule dial and the S-meter as well as the right side of the main side rule dial. A separate pilot light illuminates the left side of the main side rule dial. Interestingly, Heath uses two different types of pilot bulbs. The left bulb is a #53 and the right bulb is a #1813. Both are rated at 14.4 volts but they have different light output. The brighter bulb (the #53) is located to the left of the main dial.

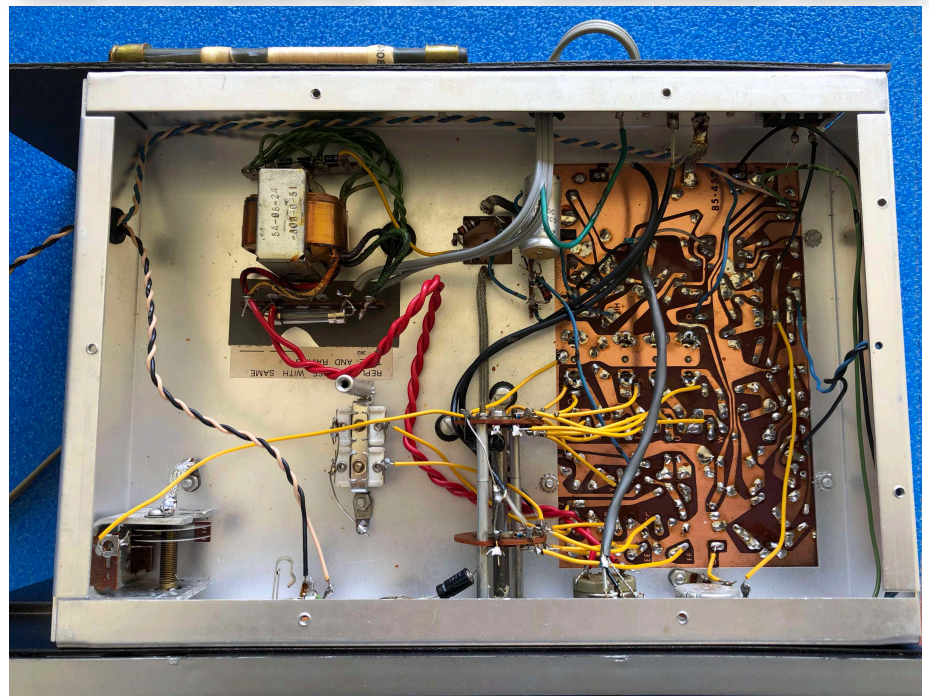


Figure 7: SW-717 under-chassis view. Bandspread capacitor is at the lower left.

**Heathkit SW-717
(S/N 133 115120)**

Last October at the auction I picked up an SW-717. At first I was a bit hesitant due mainly to the fact the main tuning knob stuck out about 3/8" more than it should, which meant perhaps the kit was modified. Or perhaps the knob was just not on correctly. The latter seemed difficult to believe. I won it in the auction, but really wasn't sure what I had.

On initial inspection the tuning shaft was definitely sticking out too far; something was amiss. there. Also one of the knobs was missing, replaced with a "chicken head" knob. Looking inside, the circuit board seemed intact but some of the tuning coils were leaning, one significantly. Later I noticed one of the ceramic filters was soldered in "catty-

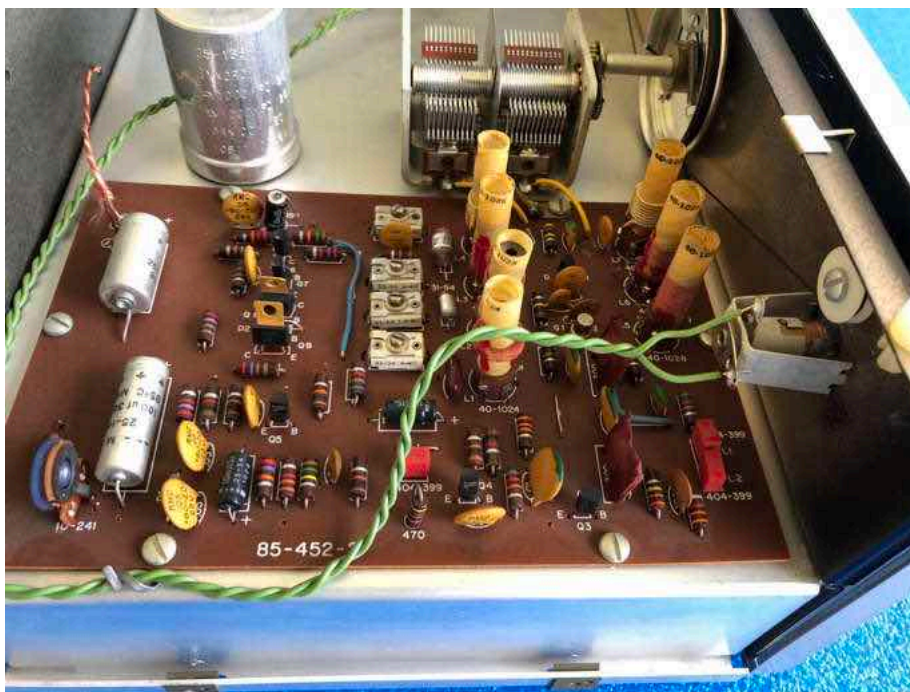


Figure 8: SW-717 showing circuit board top.

wampus". Some of the soldering was a bit messy, but no cold solder joints stood out. The radio "let out no smoke" when I first turned it on, and it worked on the AM broadcast band. A quick check with a signal generator showed all the bands were receiving, though an alignment is needed. **Figure 7** and **Figure 8** show internal views of the radio.

The tuning knob physically sticking out farther than it should was caused by the shaft bushing being installed backwards; that I fixed but then the main tuning dial required restringing; that's one of the tasks I really try to avoid.

There are a few common problems with this receiver that users have experienced. Suggested fixes are available on the web⁵. One problem is the tendency for the bandspread tuning to slip when being turned clockwise. This radio experiences that problem and the fix was tried when the front panel was removed to correct the main tuning shaft bushing. It seemed to work for awhile but is slipping again. The whole bandspread dial system is another sign the radio was compromised by cost-cutting. Instead of using pulleys, as the main tuning does, the dial string is strung around three fixed posts, and enough friction is created to cause the vernier drive of the bandspread capacitor to slip. The published solution is to stretch the dial spring slightly to reduce the tension and thus the friction. Obviously it wasn't stretched enough on the first try. Another problem is oscillation on the high end of band D, This radio is not experiencing that problem. A simple capacitor change is supposed to solve it. The third problem is distorted audio. I find the audio a bit muffled so I will try that modification.

Some users have complained of hum from the speaker, even with the volume control at minimum⁶. The fix is to add an additional RC fil-

ter network to the power supply. I have to listen hard to hear any hum and this SW-717 doesn't seem to have a hum problem.

Summary:

For casual SW listening the SW-717 makes a nice beginner's receiver. Unfortunately, there is less and less English broadcasting to listen to on the shortwave bands.

The SW-717 would not make an acceptable receiver for ham radio; it lacks features that one would need, even if they were operating as a novice back in the sixties. Still it is a kit with which a beginning kit builder could acquire confidence and enjoy playing with. A ham could use it as a simple SWL receiver. Also, a receiver like this is great on the test bench to check that oscillators are working.

73, from AF6C



NOTES:

1. For instance the GR-54 has a 1682 kHz I-F so it is designed NOT to receive frequencies between 1550 and 2000 kHz
2. It may have been introduced in a later 1971 catalog that is not in my catalog collection.
3. The GRA-72 came with 75' of antenna wire, 30' of lead-in and all insulators and hardware.
4. A copy of the SW-717 schematic is available on the W6ZE website at:
<http://www.w6ze.org/Heathkit/Sch/SW717Sch.jpg>
5. For modification info see Bill Wilkinson's webpage at:
http://www.heco.home.mindspring.com/heco_fix.html and scroll down to SW-717 near bottom.
6. For hum solution see:
<https://people.ohio.edu/posr/bapix/SW-717.htm>

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Be sure to update> Thanks - AF6C